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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
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Camera device and method for manufacturing such device

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Camera device and method for manufacturing such device

The invention relates to a camera device as defined in the pre-characterising part of Claim 1 and a method for manufacturing such a camera device.

Camera devices of this type are used in, for example, small portable devices such as mobile telephones, personal digital assistants (PDA's) and laptops.

A camera device of the type mentioned in the opening paragraph is known from the published Japanese patent application JP-2002139662. The known camera device comprises an image pick up element mounted on as substrate, and a lens support carrying one or more lenses. The lens support is integrally formed with the lenses and is fastened to the image-pick element whereby the lens support takes care of an accurate position in the main optical axis direction through the lenses and the image pick-up element. The lens images an object in front of the lens on the image pick-up element. In a manufacturing process the individual image pick element, lens support and lens are stacked and joined together. In order to obtain a high quality image of an object on the image pick up element, the dimensions of the lens support in the main optical axis direction should have a high accuracy and also positioning of these parts should be accurate.

A disadvantage of the known camera device is that in the manufacturing process each lens support has to be adjusted separately with respect to the image pick-up element in each camera device, so the known process has little capabilities to be transformed to an efficient mass production process with a high positioning accuracy.

It is an object of the invention to provide a camera device of the type mentioned in the opening paragraph having increased capabilities for an efficient mass manufacturing process with a high positioning accuracy.

To achieve this object, the display device in accordance with the invention is specified in Claim 1. In this arrangement the lens substrate including the lens element and the spacer means comprising the adhesive layer, can be positioned and aligned along the main optical axis through the lens element and the image capturing element whereafter a predetermined distance is adjusted between the lens element and the image capturing device. After hardening the adhesive layer this predetermined distance is maintained by the spacer means. The hardening of the adhesive layer can be performed in case of an ultra-violet curable adhesive by UV radiation or in case of a thermo hardening adhesive by heating the adhesive layer. This arrangement provides increased capabilities for mass manufacturing wherein a plurality of image capturing elements, lens elements and spacer means can be manufactured on a silicon wafer and a substrate respectively, whereby the wafer and the substrates are stacked and joined with a high accuracy and the individual camera devices are separated from the stack.

It is a further object of the invention to provide a method for an efficient mass production process of a camera device. This object is achieved by the method according to the invention as specified in claim 10. In this process the camera devices are manufactured by stacking a lens substrate comprising a plurality of lens elements, spacer means in the form of spacer substrate and a base substrate containing a plurality of image capture elements. The predetermined distances along the optical axis through the individual lens elements and the associated image capturing elements between the different substrates can be accurately adjusted after the stacking of the substrates and maintained by hardening of the adhesive layer between the different substrates. After completing the stack the individual camera devices can be separated from the stack. This process yields relatively cheap camera devices which are suitable for use in small electronic equipment, like mobile phones and personal digital assistants.

In embodiments the adhesive layer comprises a ultra-violet curing resin or a thermo-hardening resin.

In a further embodiment the adhesive layer has the shape of a rim situated outside the projection of the hole element on the spacer means, co-axially positioned with the main optical axis of the lens element. In this way, no adhesive material is in the optical path between the lens element and the image capturing element.

In a further embodiment the spacer means comprises a cover substrate and a spacer substrate. The cover substrate protects the image capturing element against possible damage during further manufacturing process steps.

In a further embodiment the adhesive layer can be provided between the image capturing element and the spacer substrate; and also between the spacer substrate and the cover substrate. This arrangement enables accurate adjustment after each separate step of stacking.

In a further embodiment the lens element is of a replication type. This replication type lenses enable manufacturing of high quality lenses at low costs.

In a further embodiment the lens substrate is provided with an infra-red reflection layer. Solid state image capturing elements are sensitive to infra-red radiation. By cutting off this infra-red range of the spectrum, the sensitivity of the camera device for infra-red radiation is reduced.

In a further embodiment the lens substrate is provided with an anti-reflection layer. This arrangement avoids reflection in the camera device.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a cross-sectional view of a first embodiment of a camera device,

Fig. 2 is a cross-sectional view of a second embodiment of a camera device,

Figs. 3 shows a stack of a wafer plates obtained after several subsequent manufacturing step, of the camera device before dicing out the camera devices,

Fig.4 shows a manufacturing process flow diagram of the camera device, and

Fig. 5 shows a step of dicing the stack of wafer plates.

The Figures are schematic and not drawn to scale, and, in general, like reference numerals refer to like parts.

Fig. 1 schematically shows a first example of a camera device. The camera device 1 comprises a image capturing element 3, a micro spacer plate 5 glued on the image capturing element, a cover plate 7 glued on the micro spacer plate 5 and a lens substrate 9 provided with a lens 11. The image capturing element is a conventional Charge Coupled imaging Device (CCD) or a conventional CMOS imaging device. The micro spacer plate 5 is provided a hole for passing image forming light rays from the lens element 11 to the image capturing element 3. Preferably, a infra-red reflection coating 19 is provided between the lens

substrate 9 and the cover plate 7; and an anti-reflex coating 21 is provided over the lens substrate 9 and the lens element 11. A first adhesive layer 13 of approximately 10 μm thickness is present between the micro space plate 5 and the image capturing element 3. A second adhesive layer 15 of approximately 100 μm thickness is present between the cover plate 7 and the micro spacer plate 5 and a third adhesive layer 17 of approximately 10 μm thickness is present between the lens substrate 9 and the cover plate 7. Preferably, the adhesive layers 13,15, 17 are rim-shaped whereby the adhesive material is present outside an area coinciding with the projection of the circumference of the lens element 11 on the surfaces of the micro-spacer plate 5 and the cover plate 7.

The thickness of the micro-space plate 5 is 0.4 mm. The thickness of the cover plate is 0.4 mm and the thickness of the lens substrate plate is 0.4 mm. Each adhesive layer 13,15,17 maintains the distance between the different plates to a predetermined distance with an accuracy of 5μm. In the camera device 1 the spacer means is thus formed by the micro-spacer plate 5, the cover plate 7 and the adhesive layers 13,15,17.

Fig. 2 shows a second embodiment of a camera device. This camera device 10 comprises an optical system of two lens elements 11, 27. An advantage of the two-lens optical systems is that a relative strong lens operation is obtained without much aberrations.

Parts in Fig.2 assigned the same number as in Fig. 1 corresponds to the same elements. Furthermore, Fig. 2 shows a second lens substrate 25 stacked on a second spacer place 23 and the first lens substrate 9 respectively, aligned along the main optical axis through the second lens element 27, the first lens element 11 and the image capturing element 3 and joined via adhesive layers 29,31. Preferably, a diaphragm 33 is formed from an aluminium layer provided with a hole co-axially positioned with the main optical axis of the lenses 11,27.

A manufacturing method for these camera devices comprises wafer scale manufacturing steps because multiple image capturing elements are manufactured and obtained on a substrate, for example, a silicon wafer of 20.32 cm diameter (8") . Also the spacer means and lens elements can be manufactured in many fold on substrates. Fig. 3 shows an exploded view of a stack of substrates before the individual camera device 10 are diced out. This stack 30 comprises a base substrate 34 comprising the silicon wafer 35 containing image capturing elements 3, a micro-spacer wafer 37 containing micro-spacer elements 5, a cover waver 39 and a first lens substrate 41 containing lenses 9. All these elements are available on a waver dimension scale. Furthermore, Fig. 3 shows a second ~~spacer wafer 43, a second lens substrate 45 and a further cover waver 47, necessary to obtain~~

a camera device provided with an optical system of two lenses.

Fig. 4 shows a process diagram 40 of a method for manufacturing camera devices. In a process step 20 the first lens substrate 41 is manufactured by providing an infra-red coating 19 on a glass substrate, followed by a process step P21 of forming the lens elements 11 on the glass substrate via a conventional replication process. In a further process step P22 the first lens substrate 41 is provided with an anti-reflex coating 21.

The base substrate 34 is manufactured in the following process steps. In a process step P10 a micro spacer wafer 37 is manufactured by etching holes in a glass substrate of wafer size dimension for example 20.32 cm. Alternatives for etching in this process step P10 are: laser cutting, powder blasting and ultrasonic drilling. All these techniques are well known to the person skilled in the art. In a subsequent step process step P12, the micro spacer wafer 37 and the silicon wafer 35 containing the image capturing elements, are provided with an adhesive layer via screen printing or alternatively spray coating. The adhesive layer may consists of for example an ultra-violet curable resin. Furthermore, the micro-spacer wafer 37 and the cover wafer 39 are aligned and the distance along the main optical axis between the cover plate wafer the holes of the micro spacer wafer 37 and the image surface of the associated image capturing elements 3 of the silicon wafer 35 is adjusted to a predetermined value of, for example, 900 ± 5 μm, where after the adhesive layer is cured by ultra-violet radiation. The hardened adhesive layer 15 maintains the adjusted distance. The joined wafers 35,37,39 form the base substrate 34 containing the image capturing elements 3.

In a subsequent process step P14 the base substrate 34 and the lens substrate 41 are aligned, adjusted on a predetermined distance of, for example 10 μm; and joined together via a ultra-violet curable adhesive layer 17. In a further subsequent step P15 the individual camera device are separated, for example, by securing.

In order to obtain a camera device 10 comprising an optical system of two lens elements 11,27 some further process steps P40, P41 and P31 are required. In process step P30 a second spacer wafer 43 is provided with holes for passing image forming rays. In the process step P40 the lenses 27 are formed on the second lens substrate via a replication process. Preferably, in a subsequent process step P41 a diaphragm is provided on the lens 27. The diaphragm is formed by aluminium layer with a circular hole coaxial positioned with respect to the main optical axis of the lens system. In a subsequent joining step P31 the second lens substrate plate 45 and the second spacer wafer 43 are aligned, adjusted on a predetermine distance of for example 1.67 mm; and joined via an ultra-violet curable

adhesive layer 31 of approximately 100 µm. In a subsequent process step P23, the subassembly of second lens substrate plate 45 and the second spacer plate 43 are aligned, adjusted on a predetermined distance of 121 mm with the first lens substrate plate 41, and joined via an ultra-violet curable adhesive layer 29 of 10 µm.

In the process step P14 this lens substrate assembly 44 and the base substrate sub-assembly 42 of process step P13 are aligned, adjusted on a predetermined distance and joined via an ultra-violet curable adhesive layer 29. Preferably, in this process step a third spacer plate 46 and a second cover plate 47 are stacked on the second lens substrate 45 via an ultra-violet curable layer. In a separating step p15 the camera devices 10 are sewn out of the assembled stack 50 as diagrammatically shown in Fig. 5. The assembled stack 50 is sewn via a dicing lane 52. The width of the dicing lane is approximately 230 µm. In these example a thermo-hardening adhesive can be applied instead of a ultra-violet curing adhesive.

It will be obvious that many variations are possible within the scope of the invention without departing from the scope of the appended claims.

CLAIMS:

1. A camera device comprising an image capturing element, a lens element for imaging an object at the image capturing element, a spacer means for maintaining a predetermined distance between the lens and the image capturing element, and a lens substrate for carrying the lens element characterized in that the spacer means comprises an adhesive layer.

2. A camera device as claimed in claim 1 wherein the adhesive layer has the shape of a rim outside the projection of the hole on the spacer means coaxially positioned with respect to a main optical axis of the lens element.

3. A camera device as claimed in claim 1 wherein the adhesive layer comprises an ultra-violet curing resin.

4. A camera device as claimed in claim 1 wherein the adhesive comprises a thermo-hardening resin.

5. A camera device as claimed in claim 1 wherein the spacer means further comprises a cover substrate and a spacer substrate.

6. A camera device as claimed in claim 1 wherein the adhesive layer is between the spacer substrate and the image capturing element.

7. A camera device as claimed in claim 1 wherein the adhesive layer is between the spacer substrate and the cover substrate.

8. A camera device as claimed in claim 1 wherein the lens element is of a replication type.

9. A camera device as claimed in claim 1 wherein the lens substrate is provided with infra-red reflecting layer.

10. A camera device as claimed in claim 1 wherein the lens substrate is provided with an anti-reflex layer.

11. A method for producing a camera device comprising the steps of
providing a lens substrate comprising lens elements with an adhesive layer,
stacking the lens substrate and a base substrate comprising image capturing elements,
aligning the lens substrate and the base substrate along the main optical axes through the lens elements and associated image capturing elements,
adjusting the distance along the main optical axes through the lens elements and the associated image capturing elements,
hardening of the adhesive layer and
separating camera devices from the stack of the lens substrate and the base substrate.

ABSTRACT:

The invention relates to a camera device and a method for manufacturing such a device.

The camera device comprises an image capturing element, a lens element for imaging an object at the image capturing element and a spacer means for maintaining a predetermined distance along the main optical axis though the lens and the image capturing element, and lens substrate for carrying the lens wherein the spacer means comprises an adhesive layer.

This enable a mass manufacturing process wherein parts of the individual camera elements can be manufactured in manyfold on different substrates. Where after the different substrates are stacked, aligned and joined via adhesive layers. In the manufacturing process the different distances between the plates and the wafers are adjusted and maintained via the spacer means comprising the adhesive layers. From the stack individual camera devices are sewn out.

Fig. 3

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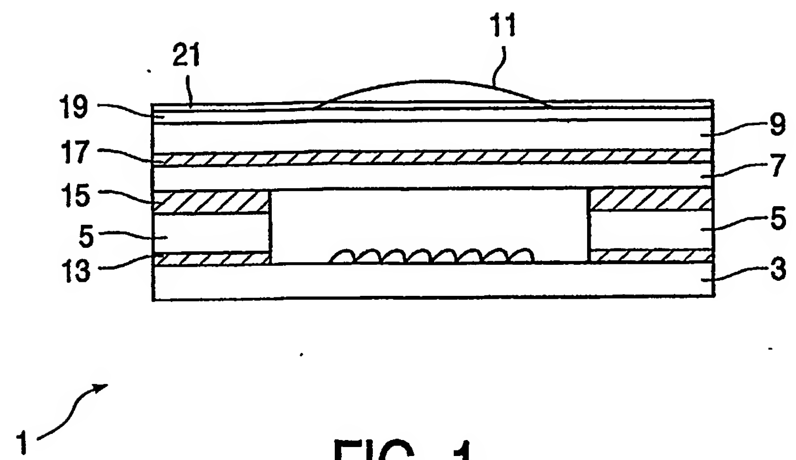

FIG. 1

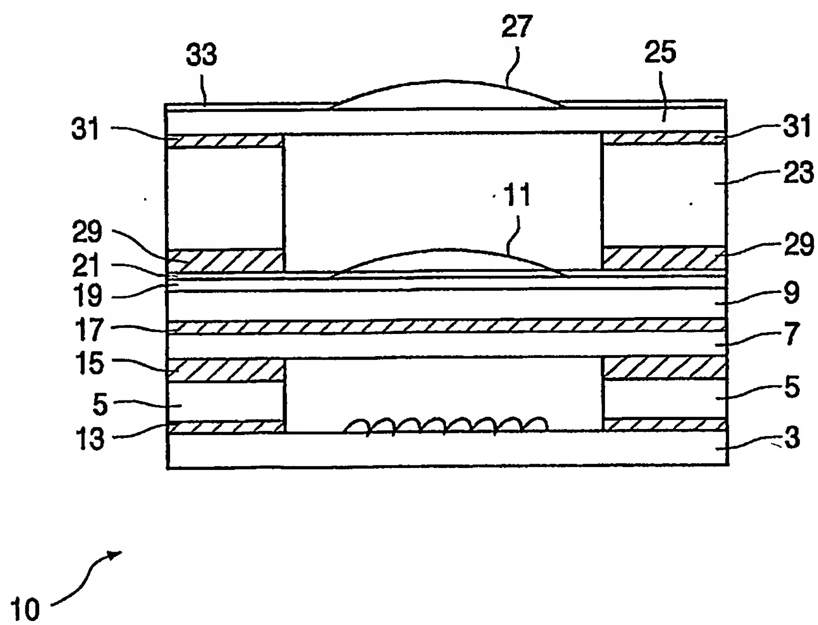

FIG. 2

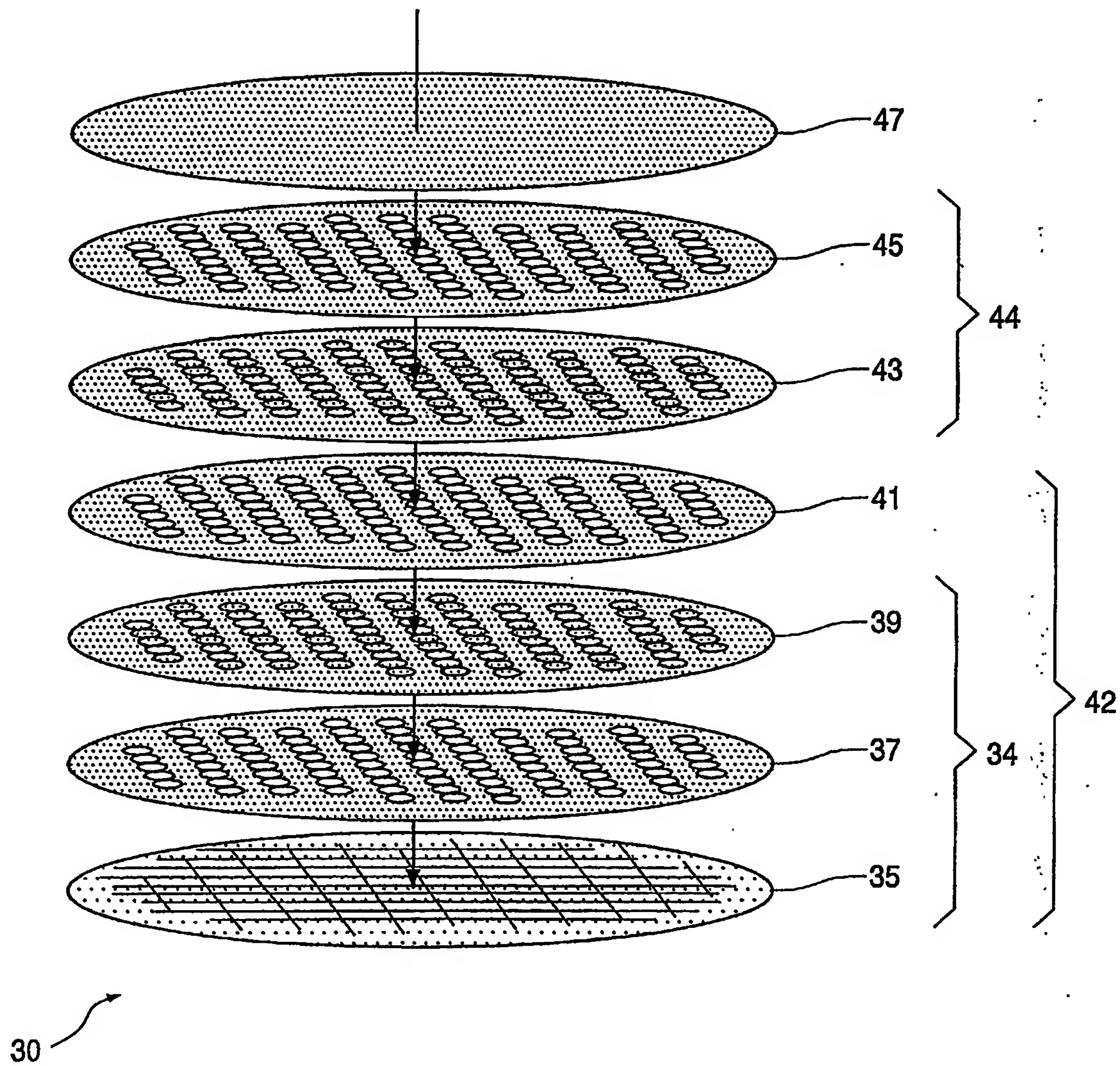

FIG. 3

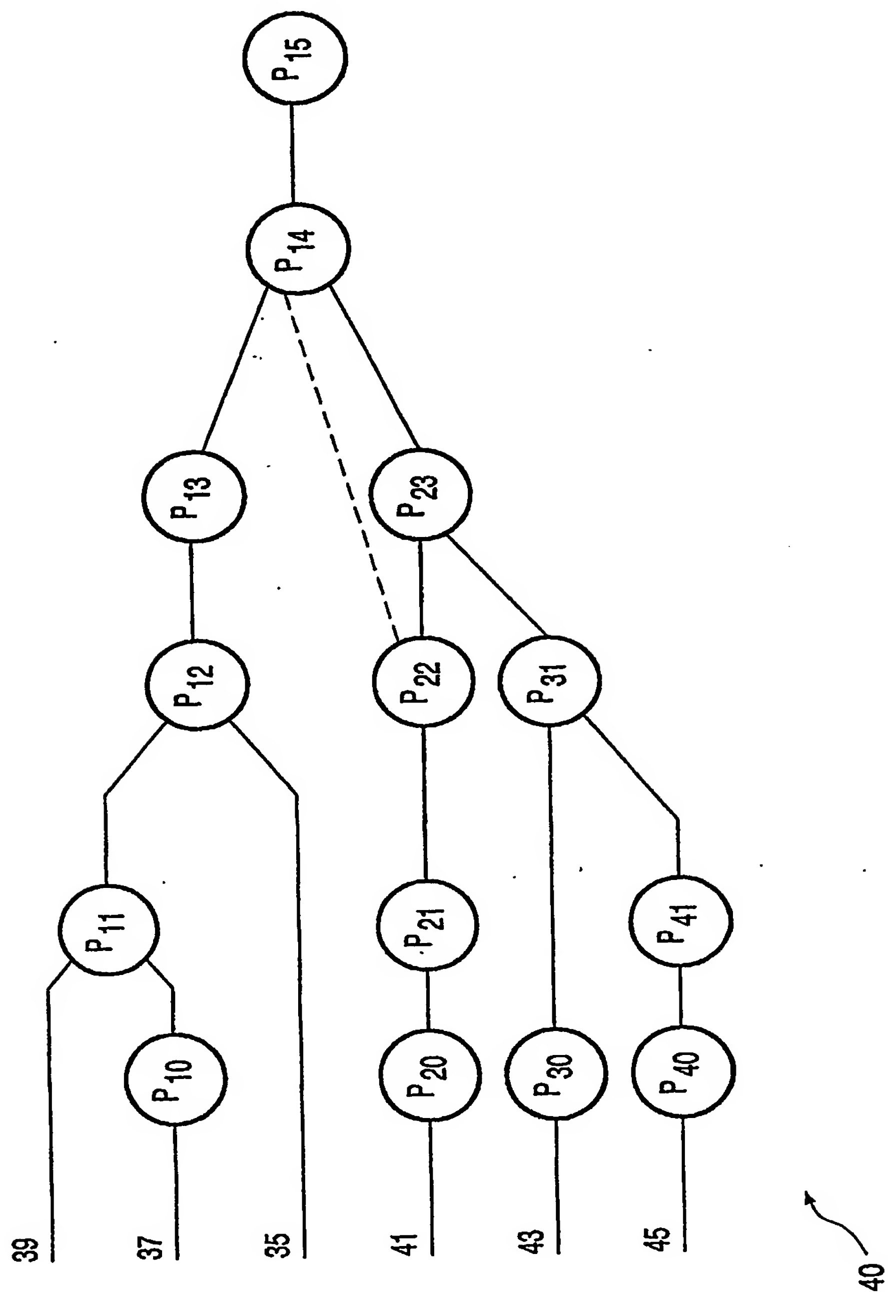
P_{15}
P_{14}
P_{13}
P_{23}
P_{12}
P_{22}
P_{31}
P_{11}
P_{21}
P_{41}
P_{10}
P_{20}
P_{30}
P_{40}
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FIG. 4

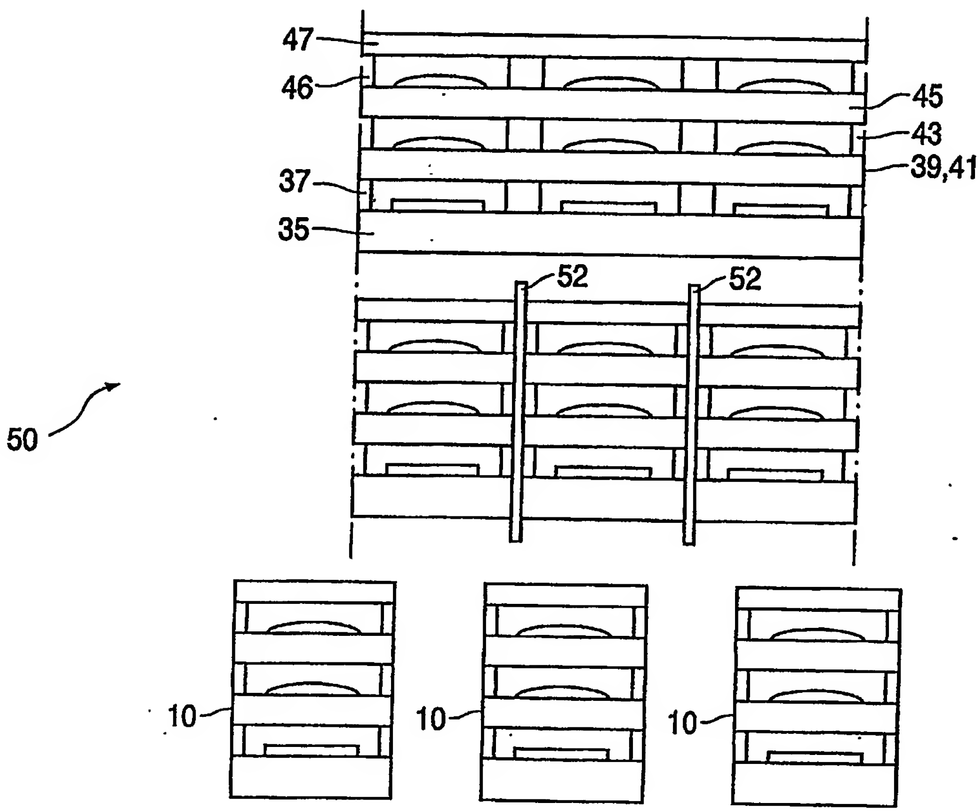

FIG. 5